

WHAT IS CLAIMED IS:

- 1 1. A band-gap reference circuit comprising:
 - 2 a first current source for generating a first reference
 - 3 current;
 - 4 a first circuit branch for receiving a portion of said
 - 5 first reference current, said first circuit branch comprising a
 - 6 first resistor having a positive temperature coefficient
 - 7 connected in series with a base-emitter junction of a first PNP
 - 8 diode having a negative temperature coefficient, wherein an
 - 9 emitter current of said first PNP diode develops a first combined
 - 10 voltage across said series connection of said first resistor and
 - 11 said base-emitter junction of said first PNP diode;
 - 12 a comparison circuit for comparing said first combined
 - 13 voltage to a base-emitter voltage of a second PNP diode and, in
 - 14 response to said comparison, adjusting a band-gap reference
 - 15 voltage; and
 - 16 a correction current generating circuit capable of
 - 17 injecting a correction current into an emitter of said second PNP
 - 18 diode, wherein said injected correction current at least
 - 19 partially offsets a non-linear drop-off in said band-gap
 - 20 reference voltage caused by said second PNP diode as temperature
 - 21 increases.

1 2. The band-gap reference circuit as set forth in Claim 1
2 further comprising a second current source for generating a
3 second reference current equal to said first reference current,
4 wherein said emitter of said second PNP diode receives at least a
5 portion of said second reference current.

1 3. The band-gap reference circuit as set forth in Claim 2
2 wherein said correction current generating circuit comprises a
3 first biased-off P-channel transistor, wherein a first leakage
4 current of said first biased-off P-channel transistor comprises
5 at least a portion of said correction current.

1 4. The band-gap reference circuit as set forth in Claim 3
2 wherein said first leakage current increases non-linearly as
3 temperature increases.

1 5. The band-gap reference circuit as set forth in Claim 4
2 wherein said correction current generating circuit comprises a
3 second biased-off P-channel transistor, wherein a second leakage
4 current of said second biased-off P-channel transistor comprises
5 at least a portion of said correction current.

1 6. The band-gap reference circuit as set forth in Claim 5
2 wherein said second leakage current increases non-linearly as
3 temperature increases.

1 7. The band-gap reference circuit as set forth in Claim 6
2 further comprising a correction current control circuit for
3 combining said first and second leakage currents to form said
4 correction current.

1 8. The band-gap reference circuit as set forth in Claim 1
2 wherein said correction current control circuit combines said
3 first and second leakage currents according to a process corner
4 of said band-gap reference circuit.

1 9. A cellular telephone comprising:
2 a voltage regulator capable of receiving a supply
3 voltage from a battery of said cellular telephone and generating
4 a regulated output voltage;
5 analog-to-digital circuitry capable of converting
6 analog signal in said cellular telephone to digital signals; and
7 a band-gap reference circuit capable of supplying a
8 band-gap reference voltage to said voltage regulator and said
9 analog-to-digital circuitry, wherein said band-gap reference
10 voltage is relatively constant across an operating temperature
11 range, said band-gap reference circuit comprising:
12 a first current source for generating a first
13 reference current;
14 a first circuit branch for receiving a portion of

15 said first reference current, said first circuit branch
16 comprising a first resistor having a positive temperature
17 coefficient connected in series with a base-emitter
18 junction of a first PNP diode having a negative temperature
19 coefficient, wherein an emitter current of said first PNP
20 diode develops a first combined voltage across said series
21 connection of said first resistor and said base-emitter
22 junction of said first PNP diode;

23 a comparison circuit for comparing said first
24 combined voltage to a base-emitter voltage of a second PNP
25 diode and, in response to said comparison, adjusting said
26 band-gap reference voltage; and

27 a correction current generating circuit capable
28 of injecting a correction current into an emitter of said
29 second PNP diode, wherein said injected correction current
30 at least partially offsets a non-linear drop-off in said
31 band-gap reference voltage caused by said second PNP diode
32 as temperature increases.

1 10. The cellular telephone as set forth in Claim 9 further
2 comprising a second current source for generating a second
3 reference current equal to said first reference current, wherein
4 said emitter of said second PNP diode receives at least a portion
5 of said second reference current.

1 11. The cellular telephone as set forth in Claim 10 wherein
2 said correction current generating circuit comprises a first
3 biased-off P-channel transistor, wherein a first leakage current
4 of said first biased-off P-channel transistor comprises at least
5 a portion of said correction current.

1 12. The cellular telephone as set forth in Claim 11 wherein
2 said first leakage current increases non-linearly as temperature
3 increases.

1 13. The cellular telephone as set forth in Claim 12 wherein
2 said correction current generating circuit comprises a second
3 biased-off P-channel transistor, wherein a second leakage current
4 of said second biased-off P-channel transistor comprises at least
5 a portion of said correction current.

1 14. The cellular telephone as set forth in Claim 13 wherein
2 said second leakage current increases non-linearly as temperature
3 increases.

1 15. The cellular telephone as set forth in Claim 14 further
2 comprising a correction current control circuit for combining
3 said first and second leakage currents to form said correction
4 current.

1 16. The cellular telephone as set forth in Claim 9 wherein
2 said correction current control circuit combines said first and
3 second leakage currents according to a process corner of said
4 band-gap reference circuit.

1 17. A method of operating a band-gap reference circuit
2 comprising the steps of:

3 generating a first reference current;

4 receiving a portion of the first reference current in a
5 first circuit branch comprising a first resistor having a
6 positive temperature coefficient connected in series with a base-
7 emitter junction of a first PNP diode having a negative
8 temperature coefficient, such that an emitter current of the
9 first PNP diode develops a first combined voltage across the
10 series connection of the first resistor and the base-emitter
11 junction of the first PNP diode;

12 comparing the first combined voltage to a base-emitter
13 voltage of a second PNP diode;

14 in response to the comparison, adjusting a band-gap
15 reference voltage; and

16 injecting a correction current into an emitter of the
17 second PNP diode, wherein the injected correction current at
18 least partially offsets a non-linear drop-off in the band-gap
19 reference voltage caused by the second PNP diode as temperature
20 increases.

1 18. The method of operating a band-gap reference circuit as
2 set forth in Claim 17 further comprising the step of generating a
3 second reference current equal to the first reference current,
4 wherein the emitter of the second PNP diode receives at least a
5 portion of the second reference current.

1 19. The method of operating a band-gap reference circuit as
2 set forth in Claim 18 further comprising the step of generating
3 at least a portion of the correction current from a first leakage
4 current of a first biased-off P-channel transistor.

1 20. The method of operating a band-gap reference circuit as
2 set forth in Claim 19 wherein the first leakage current increases
3 non-linearly as temperature increases.

1 21. The method of operating a band-gap reference circuit as
2 set forth in Claim 20 further comprising the step of generating
3 at least a portion of the correction current from a second
4 leakage current of a second biased-off P-channel transistor.

1 22. The method of operating a band-gap reference circuit as
2 set forth in Claim 21 wherein the second leakage current
3 increases non-linearly as temperature increases.